

WHAT IS CLAIMED IS

1. A method for the synthesis of large area uniform silicon cone arrays on a substrate by ion-beam sputtering, wherein total pressure is kept at 2×10^{-4} Torr, silicon is used as a substrate, and a metal is used as a catalyst.
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2. A method as claimed in claim 1 wherein the sputter gas is selected from any of helium, neon, argon, xenon and hydrogen.
3. A method as claimed in claim 1 wherein the catalyst is selected from any of the group consisting of molybdenum, tungsten and nickel.
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4. A method as claimed in claim 1 wherein the substrate temperature ranges from 100°C to 600°C .
5. A method as claimed in claim 1 wherein the ion energy is maintained in the range of 100eV to 1000eV.
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6. A method as claimed in claim 1 wherein the angle between the center ion-beam and the substrate surface normal ranges from 0 to 90 degrees.
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7. A method as claimed in claim 1 wherein the fabrication time is between 30-240 minutes.
8. A method for the synthesis of large area uniform cone arrays made of a first material by ion-beam sputtering, wherein the first material is used as a
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substrate, and a second material is used as a catalyst, wherein the second material is a metal.

5 9. A method as claimed in claim 8 wherein the first material is selected from the group consisting of germanium, copper, or graphite.

10 10. Apparatus for ion-beam sputtering of large area uniform silicon cones, comprising a high vacuum chamber suitable for ion-beam sputtering, an ion-source, means for holding a substrate in the chamber, means for arranging a metal catalyst around the substrate, means for adjusting the substrate temperature and means for adjusting the angles between the center ion-beam and the substrate surface normal.

15 11. Apparatus as claimed in claim 10 wherein the ion source is an rf ion source or a Kaufman ion-source.

12. Apparatus as claimed in claim 10 wherein the substrate holder clamp is made of molybdenum, tungsten, or nickel.

20 13. A method for silicon cone surface modification by acid etching, wherein a hydrofluoric acid is used as an etchant, and de-ionized water is used as a stopper.

25 14. A method as claimed in claim 13 wherein the concentration of hydrofluoric (HF) acid ranges from 1 % to 48%.

15. A method as claimed in claim 13 wherein the etching time is between 10 seconds to 10 minutes.

5 16. A method as claimed in claim 13 wherein the acid used is selected from HF acid, or a mixture of HF acid and HNO_3 , HCl , or H_2SO_4 .

17. A method for silicon cone surface modification comprising annealing under ultra-high vacuum conditions.

10 18. A method as claimed in claim 17 wherein the annealing temperature is between 100 to 800°C.

15 19. A method as claimed in claim 17 wherein the annealing time is between 10-30 minutes.

20 20. A method for silicon cone surface modification by low work function metal coating, wherein a low work function material is used as a coating material.

21. A method as claimed in claim 20 wherein the low-function coating material is selected from Cesium and diamond like carbon (DLC).

22. A method as claimed in claim 20 wherein the coating thickness ranges from 100 to 1000 angstrom.

23. A method for growing silicon oxide nanowires on the tips of the silicon cones by heating, wherein the silicon cone is used as the substrate, metal/metal silicide cone tip is used as the catalyst, and inert gas is used as a protective gas.
- 5 24. A method as claimed in claim 23 wherein the inert gas is selected from helium, neon, argon, and xenon.
25. A method as claimed in claim 23 wherein the total pressure during growth is maintained at 15 to 25 Torr.
- 10 26. A method as claimed in claim 23 wherein the growth time is between 5 to 10 minutes.
- 15 27. A method as claimed in claim 23 wherein the growth temperature ranges from 900 to 950°C.
- 20 28. A method for growing crystalline silicon nanowires on the tips of the silicon cones by heating, wherein the silicon cone is used as the substrate, metal/metal silicide cone tip is used as the catalyst, inert gas is used as a protective gas, and hydrogen is used as a reductive gas.
29. A method as claimed in claim 28 wherein the inert gas is selected from helium, neon, argon, and xenon.

30. A method as claimed in claim 28 wherein the total pressure during growth is maintained at 15 to 25 Torr.
- 5 31. A method as claimed in claim 28 wherein the growth time is between 5 to 10 minutes.
32. A method as claimed in claim 28 wherein the growth temperature ranges from 900 to 950°C.
- 10 33. A method as claimed in claim 28 wherein the ratio between the inert gas and hydrogen ranges from 90:10 to 0:100.
34. A method as claimed in claim 28 wherein a hot filament excitation is employed.
- 15 35. A method as claimed in claim 34 wherein the filament temperature is maintained in the range of 1800°C to 2300°C.
- 20 36. A method as claimed in claim 34 wherein the excitation can be from rf, microwave or dc plasma source.
- 25 37. Apparatus for the high temperature growth of nanowires on tips of the silicon cones, comprising a vacuum chamber, means for holding a substrate in the chamber, means for supporting filaments in the chamber, and means for adjusting the substrate temperature.